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BHI-00892
Rev. 0

Safety Analysis for the 233-S Decontamination and Decommissioning Project

HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Bechtel Hanford, Inc.
Richland, Washington

BHI-00892
REV: 0
OU: N/A
TSD: N/A
ERA: N/A

APPROVAL PAGE

Title of Document: SAFETY ANALYSIS FOR THE 233-S DECONTAMINATION AND DECOMMISSIONING PROJECT

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BHI-DIS 8/14/96

BHI-00892
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Date Published
August 1996

Environmental Excellence
HANFORD

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EXECUTIVE SUMMARY

Decommissioning of the 233-S Plutonium Concentration Facility is a proposed expedited response action (ERA) that is regulated by the *Comprehensive Environmental Response Compensation and Liability Act of 1980* (CERCLA) and the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). The 233-S Facility was built in 1955 to increase production of plutonium nitrite solution from the Reduction-Oxidation Plant (REDOX) and operated until 1967 with several facility modifications being performed. Due to progressive physical deterioration of this facility, a decontamination and decommissioning (D&D) plan is being considered for the immediate future. This safety analysis describes the proposed actions involved in this D&D effort, identifies the radioactive material inventories involved, reviews site specific environmental characteristics and postulates an accident scenario that is evaluated to identify resultant effects.

The accident scenario evaluated postulated an inadvertent droppage of a process vessel section during removal and a chain of events that resulted in a fire with uncontrolled facility system effects. The end result of this postulated accident was the release of radioactive materials to both the facility's interior and environmental surrounding. Assumed worse case conditions and reasonable facility and environmental reactions were incorporated into the evaluation to show that the accident consequences results in negligible offsite exposure of individuals and onsite exposures within acceptable DOE administrative guidelines. The effects of this accident were further interpreted that only an operational emergency class of "alert" would be imposed on the facility and its surrounding immediately following the accident if risk factors are properly managed. It is the conclusion of this safety analysis that the operations proposed by the 233-S Facility D&D project can be conducted with no undue risk to the public, the environment or project workers.

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ACRONYMS AND DEFINITIONS

ARF	airborne release fraction
ASA	Auditable Safety Analysis
BHI	Bechtel Hanford, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
HASP	health and safety plan
HEPA	high-efficiency particulate air
HEW	U.S. Department of Health, Education, and Welfare
PAG	Protective Action Guides
PHA	preliminary hazards analysis
PR	plutonium removal
RDR	remedial design report
REDOX	Reduction Oxidation (Plant)
RF	respirable fraction
SEG	Scientific Ecology Group, Inc.
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
WHC	Westinghouse Hanford Company

1.0 INTRODUCTION

This ASA supplements the discussion in the EE/CA identification of the hazards associated with the D&D project and assesses the adequacy of the measures taken to eliminate or mitigate identified hazards in order to provide adequate protection of human health and the environment. The ASA defines the safety basis utilizing the combination of information relating to the control of hazards such as the preliminary hazards analysis (PHA) and the criticality evaluation (BHI[c] 1996). The ASA provides supporting documentation for the engineering evaluation and cost analysis that is required under CERCLA and the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990). Detailed safety controls and commitments will be defined in subsequent documents that will support the Remedial Design Report (RDR) and other documents and implementing procedures. A summary of the engineering controls and safety commitments are presented in Section 4.0 and the PHA is provided in Appendix A.

1.1 PURPOSE AND OBJECTIVES

The objective of the 233-S D&D project is to perform those tasks required to remove the residual radiological inventories in the 233-S facility, its equipment and associated systems, and to restore the area to an acceptable environmental status. The D&D activities will be conducted in two phases: Phase I will include the removal of all internal and external equipment and systems; and radiological preparation of the facility for demolition and Phase II will include the careful dismantlement of the building structures, removal of subsurface systems, and appropriate disposal of generated waste. No concerted effort is planned to decontaminate the equipment being removed from the facility unless transuranic (TRU) waste can readily be converted to low-level waste. Therefore, individual pieces will be sorted according to radiation characteristics (TRU, low-level radioactive waste, or free release material) and managed in accordance with applicable requirements. Free release materials such as building rubble and uncontaminated equipment will be recycled or disposed of in an approved landfill. The waste packaging area will be located within the 233-S Facility to permit ease of operation and eliminate excessive precautionary measures required for inter-building transportation.

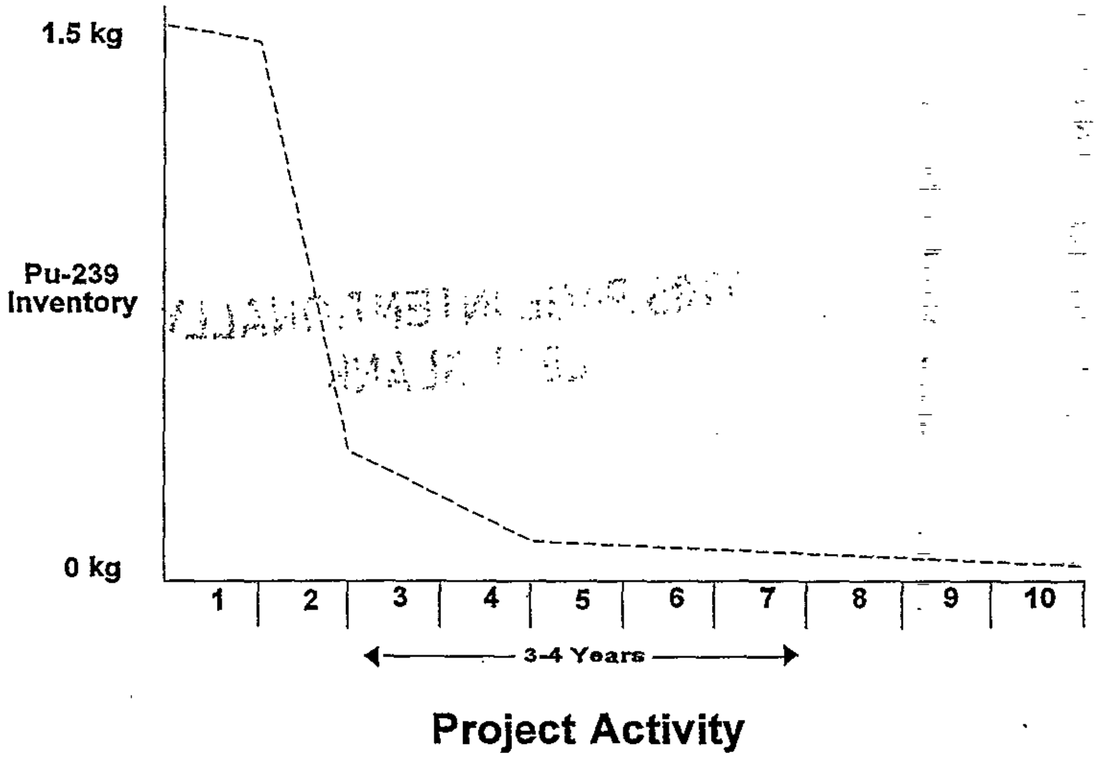
Since progression of the 233-S D&D project will steadily reduce the plutonium-239 inventory, it is anticipated that potential radiological hazards will be similarly reduced. Figure 1 provides a simplified preliminary schedule of the D&D depicting the inventory reduction and suggesting the hazards minimization that may be anticipated. Planned D&D activities are discussed in Section 2.1.

1.2 SAFETY SUMMARY

Radiological consequences due to accidents or upsets were found to be primarily localized to the interior of the 233-S Facility and near proximity. Decommissioning workers are the most likely receptors at risk to radiological exposure. However, the local environment is also potentially at risk. The environmental hazards include deterioration from freeze and thaw cycles that threaten the confinement of the radiological inventories and from worker-caused accidents that could jeopardize the building's confinement systems.

Engineering controls and implementing procedures will be developed during the definitive phase to support the RDR. Institutional controls found in codes and standards such as 10 CFR 835, Occupational Radiation Protection, have been determined to be sufficient to provide commitments to establish, maintain, and implement the health and safety programs for the 233-S D&D project. Further commitments deemed necessary to provide control of the hazards of this project is the development and maintenance of a site-specific health and safety plan (HASP). A criticality safety evaluation was performed that supported a conclusion that a criticality accident is highly unlikely. Institutional controls determined to be necessary to support the project will be directed, as appropriate, through the safety management program, as the project develops. Verification of radiological inventory characteristics will be performed to ensure validity of the assumptions used in the ASA. Section 3.0 and the PHA present more details regarding the evaluation of the hazards. Section 4.0 summarizes the engineering controls and safety commitments for the project.

Figure 1. 233-S D&D Schedule and Suggested Hazards Reduction.



Project Activity Designators:

1 = Pipe Trench Isolation
2 = Process Hood Removal
3 = Load-Out Hood Removal
4 = Ventilation Ductwork Removal - 233-S
5 = Filter Plenums Removal
6 = Ventilation Ductwork Removal - 233-SA
7 = Post Decontamination - 233-S/SA
8 = Dismantlement - 233-S/SA
9 = Filter Box/Pipe Trench Remediation
10 = Final Survey

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2.0 BACKGROUND INFORMATION

2.1 PROJECT DESCRIPTION

The 233-S D&D project is described in detail in the facility D&D plan (Bechtel Hanford, Inc. [BHI] [BHI 1996[b]]). This section presents a general description of the planned activities in the anticipated sequence of operation.

The process area is a four-story-high bay with 30.5-cm (12-in.) thick concrete walls and is divided into two zones. The two zones, the process hood, and the viewing room are separated with a partition of transparent panels and reinforced structural steel. The viewing room has open-grate flooring on each of the upper three levels with an access ladder in the southwest corner. The process hood is 9.7 m (32 ft) high and contains a process system array with geometrically safe process vessels up to 7 m (23 ft) tall and 17.8-cm (7-in.) inside diameter. A vessel listing is provided in Table 1 and vessel locations in the process cell are presented in Figures 2 and 3.

The pipe gallery contains non-process support lines from the REDOX Plant that enter the area through the viewing room. Equipment in the room includes instrument lines, steam lines, a chemical makeup tank (empty) and a variety of control panels. The control panels are separated from the process area by Lucite panels that isolate the control room. The equipment room contains the necessary equipment, ducting, and wiring once used to provide and control facility make-up air. The facility water and non-process steam lines have been disconnected and the electrical utilities have been deactivated.

Work planning has addressed the pipe gallery activities including the removal of asbestos wrapped steam lines and insulated raw water lines, process air lines, and instrument lines. Once fixation and/or removal of loose contamination is accomplished it will be necessary to remove the control panel and chemical makeup tank in order to decontaminate the walls, floors, and ceilings.

The loadout and decontamination room is located on the north side of the process hood. The loadout hood is located on the south side, or common wall with the process hood and is a containment type work station. The can storage rooms are on the north side of the loadout room.

Table 1. 233-S Process Equipment List In Use Prior to Shutdown.

ID	Name	Status	Vol (gals)	Dwg No.	Description
L-1[1]	Feed Tank		30	H-2-45284	2 ch. 10 pipe
L-2	Np Concentrator[2]		9.25	H-2-17922	7"IDx23'H, 44"W, 10' of total packing
L-3[1]	Product Concentrator[2]			H-2-30928	Upper - 2 (7" x 8') Titanium Raschig Packing; Lower tube bundle (6" x 6' sch. 10)
L-4[1]	Product Receiver		14	H-2-17929	2 (6" x 4.5H) pipes sch. 10
L-5[1,3]	Product Filter	Unknown	2	H-2-39993	2.5" x 14" carborundum filter inside a 6" x 17" pipe assembly
L-6	Pu Product Sampler		13.4	H-2-17930	3" x 15' horiz, 5" x 30" vert. sch. 40
L-7	Pu PR Head Tank	Removed	2.5	H-2-18087	Pyrex[4] Glass 6" x 21"H
L-8	Np Conc. Condenser		5.3	H-2-17923	7" x 4.5', 20" W overall
L-9	Condensate Sampler		6	H-2-18030	8" x 40" L, 30" W overall sch. 40
L-10F[1]	L-18 Feed Tank		96	H-2-17928	3 (6" x 22') with 2" sch 40 risers
L-10W[1]	L-18 Waste Tank		64	H-2-17928	2 (6" x 22') with 2" sch 40 risers
L-11[1]	Concentrator Condenser			H-2-7252	6" x 6' L, 5' tube bundle
L-12	Pu Product Concentrator[2]			H-2-30703 H-2-56715	Overall 6" x 22'H with 9'H side stm col, 5' W overall (6" x 6' sch. 10 tube bundle)
L-12 mon	Pu Product Concentrator Monitor		1	H-2-30911	Same as L-18 mon
L-13	XAF Conc. Cond. (Pu)			H-2-7252	Same as L-11
L-14	Pu Transfer Trap		14	H-2-17929	Same as L-4
L-15	Jet Condenser			H-2-7252	Same as L-13
L-16	Pu Recycle Tk		18	H-2-30820	3 (6" x 56"H) sch. 40 pipe
L-18[1] mon	Anion IX Column Monitor		1	H-2-30911	6" sch 10 x 9" H w/polyethylene shielding (19" OD) same as L-12 mon
L-21	Np Load-out Tk	Removed	2.2	H-2-30902 H-2-30904	Pyrex 6" x 18"H
L-22	Recycle Tk to L-16	Removed	5	H-2-45287	Pyrex 6" x 36"H
LS-1	Vent Sump	Unknown	3.6		
L-1A	Make-up tank		195	H-2-17931	3' x 5' H overall, 1" tube coil inside tank
	Loadout Hood Sump		< 0.1	H-2-18089	1.5" x 4" deep sch. 40 loadout Hood Sump

[1] Equipment NOT in use in 1964 after the fire.
[2] Concentrators are titanium with 1-in. tube bundles.
[3] L-5 product filter existence is uncertain but may have high dose rate; located in lower-front of process hood - 6 ft to left of IX column and behind viewing room floor drain position.
[4] Trademark of Corning Glass Works.

Figure 2. 233-S Plutonium/Neptunium Processing Facility (East Elevation).

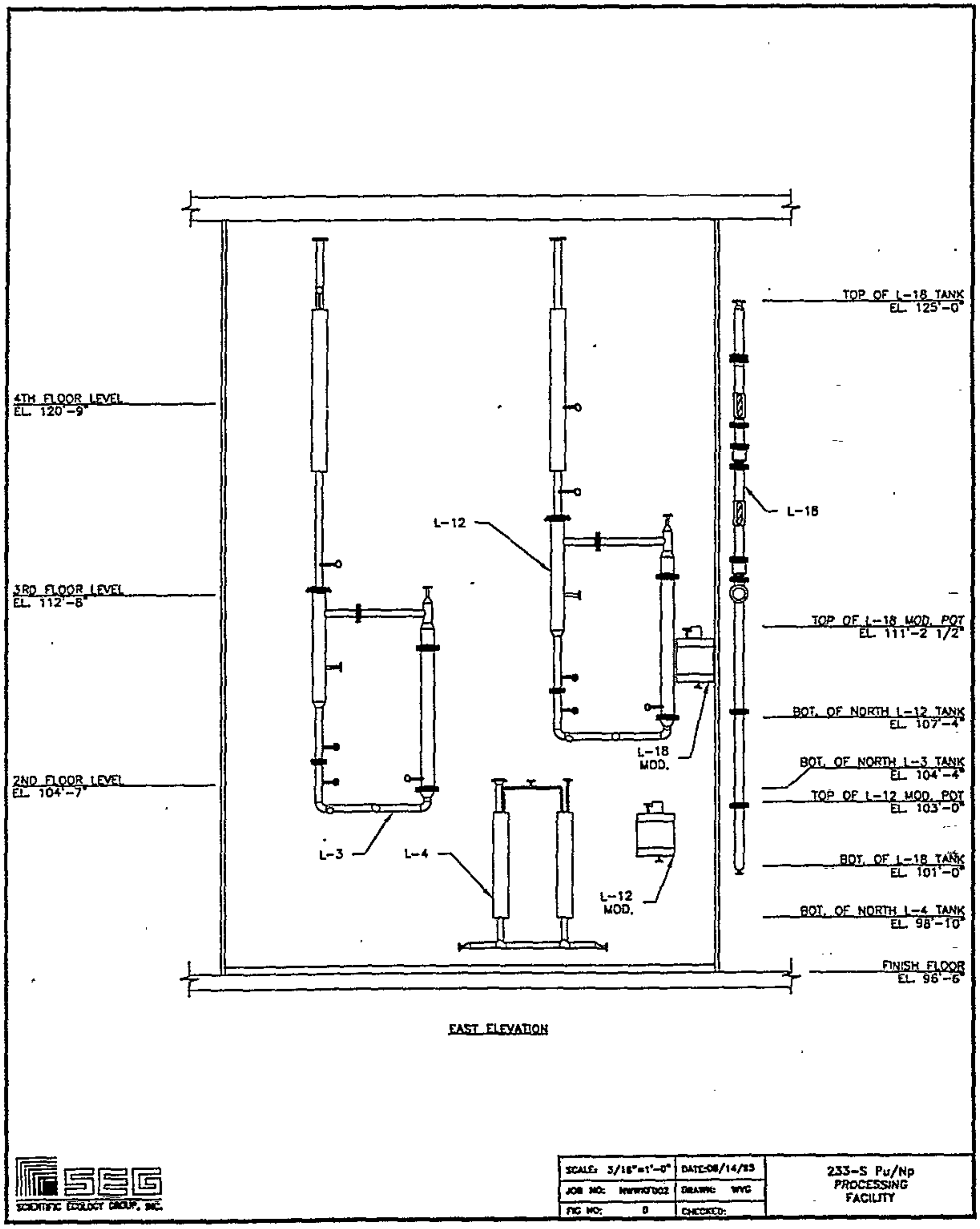
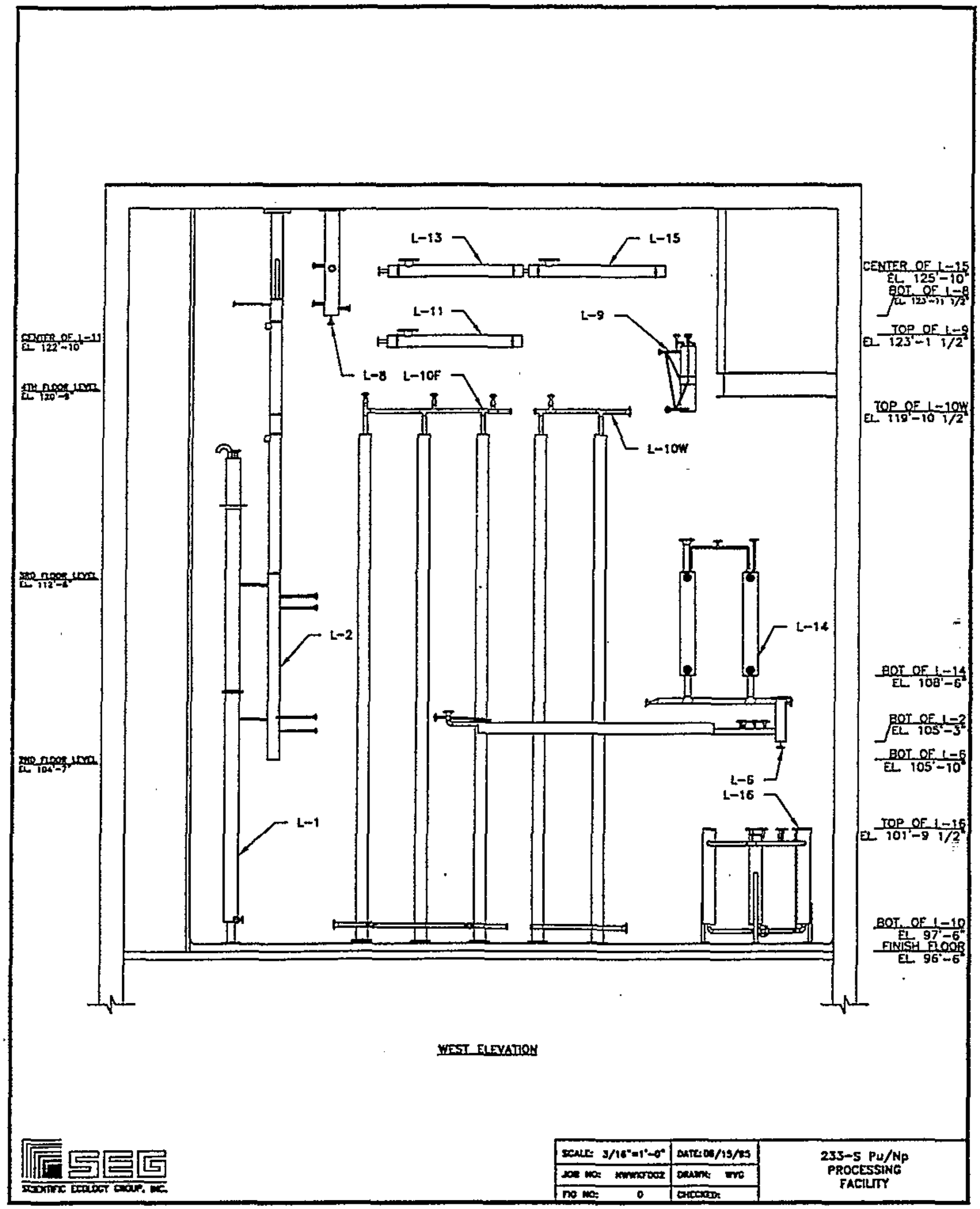


Figure 3. 233-S Plutonium/Neptunium Processing Facility (West Elevation).



Prior to the D&D of the loadout hood a confinement enclosure will be established around the entire hood. Air flow within this enclosure will be directed to the hood exhaust and if necessary, a high-efficiency particulate air (HEPA) filtered blower system will be attached to the enclosure to provide the air flow controls. Initial in-hood operations will be surface vacuuming or absorbent wiping of the internal hood surfaces. Then the surfaces will be coated with a fixative readying the hood for dismantlement. Powered hand tools will be used to section the hood into appropriate pieces. After the entire hood has been removed, the exhaust ducting will be modified to minimize the spread of airborne contaminants. Removal of the confinement enclosure will be completed by wiping the inner layer with absorbent wipes and then removing the inner layer. A fixative coating may also be applied to the inner layer if necessary and then the remainder of the enclosure will be disassembled.

The pipe trench is a concrete subgrade structure running between the REDOX Plant and the southeast corner of the 233-S Facility. The pipe trench is divided into two sections with cover blocks that have metal plates concealing recessed lifting bails. A neptunium pipe trench with metal covers is located adjacent to the pipe trench. Removal of the pipes in the trenches will be performed to eliminate sources of contamination and to reduce the radioactive material inventory of the facility.

The viewing room is adjacent to the process hood and provides access to upper levels of the process hood via three open grating walkways along the east and south sides of the process hood enclosure. The walkways are located so as to divide the height of the cell into approximately equal sections of 2.4 m (8 ft). The east and south faces of the hood are constructed of Lucite (a trademark of E. I. du Pont de Nemours & Company) panels that are supported by steel frame members. There are usually two Lucite panels between each level and in some cases double panels have been installed. At the north end of the hood, a floor at the upper level supports (now de-energized) electric and process instrumentation equipment.

Equipment dismantlement in the process hood will require installation of an in-cell rigging system, modification or adjustments of the ventilation system, and in-hood preparatory cleaning. Cleaning will be achieved by scooping or vacuuming techniques. Following the hood cleaning operations, the equipment systems in the process hood will be drained of remaining liquids and cut into sections in place. (The process piping was drained and isolated as part of facility deactivation. The planned draining activity is precautionary, no free liquid is anticipated).

Lowering of sectioned equipment to the lower level will be carefully performed and removal of sectioned segments will be pre-planned so that hang up and excessive handling is not required. Once each segment has been lowered to the ground floor level, it will be removed to the waste packaging support enclosure. Existing unistruts and pad-eyes embedded into the roof will be used as rigging points as they were initially used to hoist the equipment into place during construction. Engineering evaluations of these lifting points will be conducted to verify their condition prior to their use. An I-beam roof support over the upper walkway also exists that can be used to support equipment removal from that level. Tie-off or bracing of the system segments as they are cut will be accomplished from overhead rigging (previously installed) or from localized structures adapted for this purpose. It is anticipated that the equipment removal will progress from the lower levels of the process hood to the upper levels.

Once the building equipment has been removed the interior ductwork will be readied for dismantlement. This effort will involve installing sealed caps on all ducting at the wall or ceiling surfaces where they enter the rooms. Where the ductwork extends into rooms, hallways or overheads, those sections will be cut and removed. The interior ductwork contained in the facility's walls and ceilings will have fixative applied prior to their removal during building dismantlement.

At this point of the project, additional decontamination of the walls, ceilings, and floors will be performed in preparation for dismantlement. A decision to remove the floor drainage system will be made considering two options: (1) removal prior to building dismantlement or (2) removal after the building is removed.

The 233-S D&D project will then proceed with the removal of the exterior ventilation ductwork. Duct removal will start from the outer most outlet and move to the closest connection to the HEPA filters. Once all the ductwork is removed the equipment in the 233-SA Building will be removed. The removal of the roughing and HEPA filters will be performed using existing procedures. Filter plenums, interior ductwork, and supporting equipment will be disassembled and cut and then the same methods used to decontaminate the 233-S Facility will be used on this building.

The 233-SA Exhaust Filter Building is a one-story, 4.9-m (16-ft) by 7.3-m (2-4 ft) reinforced concrete structure with 15.2-cm (6-in.) walls. The 233-SA Exhaust Filter Building is located on a 20.3-cm (8-in.) thick reinforced concrete pad at the northeast corner of the 233-S Facility. The 233-SA Exhaust Filter Building contains two parallel filter banks. Each bank has a prefilter and a series of double HEPA filters with its own exhaust fan, 7.6-m (25-ft) high metal stack, and sampling equipment. The fans and stacks are located to the north of the building.

An abandoned filter box made of a reinforced concrete structure located below grade lies between the REDOX Plant and the 233-S Facility. The filter box is approximately 1.8 m (6 ft) wide by 1.8 m (6 ft) deep by 3.65 m (12 ft) long with 15.2-cm (6-in.) thick walls.

After decontamination activities have been completed within the 233-S and 233-SA facilities, final dismantlement efforts will proceed. These efforts include de-energizing, locking out, and tagging out all remaining facility systems and disconnecting all facility utility systems. The dismantlement will be from the top of the facilities to the bottom.

Once the facilities have been dismantled, the floor slab footers, filter box, and pipe trench will be removed. These locations will have been decontaminated using the same methods used for the 233-S and 233-SA facilities. After a final survey of the 233-S D&D site has been performed and any residual contaminants are removed or adequately isolated, the project will be complete.

2.2 RADIOACTIVE INVENTORY

The 233-S Facility contains the vast majority of radioactive material inventory associated with the D&D project. In 1995, a survey was conducted to identify locations where plutonium may be held up and to determine the quantity of material at each location. The survey included four locations within and around this facility. These locations include (1) the abandoned filter box and pipe trench between the 233-S Facility and REDOX Plant, (2) the column lay down trench, (3) the 233-S loadout hood and (4) the 233-S process hood. Of these locations the process hood had neutron activity levels that were considerably higher than the other locations. The methodology used to conduct the surveys and provide the estimates of plutonium hold up is provided in the non-destructive assay report (BHI[a] 1996). Table 2 shows the estimated plutonium inventories of vessels contained within the process hood. These surveys concluded that appreciable quantities of plutonium do not exist within the structures. It was noted, however, that lack of knowledge regarding the thickness, density, and elemental composition of panels and covering materials for the filter box and trenches preclude making this judgement definitive. This analysis assumes filter box, trench, and loadout hood radioactive material inventories are not significant, with respect to the hazards they pose to individuals outside the 233-S Facility. For the loadout hood, surface contamination exists as finely distributed material.

Table 2. Facility Segment Plutonium-239 Inventories.[1]

Segment	Pu-239 (gm)	1 Sigma Error
L-4	150	70
L-6	200	70
L-12N	130	60
L-12S	120	50
L-14	250	175
L-16	530	250
L-18	150	50

[1]BHI[a] (1996)

The 233-SA Exhaust Filter Building is expected to contain radioactive material inventories within the plenums that exists as surface contamination. The filters are anticipated to have a greater inventory of material; however, existing ventilation requirements limit the potential inventory accumulations.

Nonradiological hazard inventories within these facilities are assumed to be present only in minimal quantities. The chemicals historically used do not represent the current inventory; i.e., no bulk quantities. Over the years, and particularly during deactivation, flushing of the process lines and equipment were performed and some of the chemicals have evaporated or decomposed. Some of these chemicals were used in extremely minute quantities and some of the equipment containing chemicals was removed. Thus, the largest known quantities of hazardous material include a substantial inventory of asbestos insulation within the facilities and lead is possibly contained in the paint and fixative coatings.

2.3 DEMOGRAPHICS

The D&D activities to be conducted will be supported by D&D technicians, Radiological Control Technicians, Craft Support, and D&D engineering. The composite of individuals assigned to specific D&D project tasks will be approximately 10 with occasional additions of specialists to perform specific activities.

The 233-S Facility is located just north of the 222-S Laboratory complex. This complex is the closest (by an order of magnitude) operating facility outside the zone of control of the project. Calculations presented in Section 3.1 of this report show that the occupants of the 222-S Laboratory complex will not be subjected to undue risk by the planned 233-S D&D project.

2.4 SITE FEATURES

This section discusses environmental characteristics of the Hanford Site and site-specific characteristics associated with the 200 West Area. Unless specifically noted, this information is taken from the draft Environmental Assessment for 233-S D&D (DOE 1996).

The DOE's Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State. The Hanford Site occupies an area of about 1,450 km^2 north of the confluence of the Snake and Yakima Rivers with the Columbia River. This land, with restricted public access, provides a buffer for the areas used for storage of nuclear materials and waste management; only about 6% of the land area is actively used. Adjoining lands to the west, north, and east are principally range and agricultural land. The cities of Richland, Kennewick, and Pasco (Tri-Cities) constitute the nearest population center and are located southeast of the Hanford Site. Richland is approximately 40 km southeast of the 200 Areas, and in 1993, had an estimated population of 34,080. The estimated total 1993 population within an 80-km radius was approximately 380,000. Regional land use includes dryland and irrigated farming, rangeland, wildlife reserves, vineyards, orchards, and industrial and residential development.

The Hanford Site has a dry climate, with an average of 16-cm annual precipitation. Average monthly temperatures range from a low in January of -0.9 °C to a high in July of 25 °C. Prevailing winds are usually from the northwest. Wind speeds are highest during the summer months, averaging 14 to 16 km/hr. Air quality in the Hanford region is well within the state and federal standards for criteria pollutants, except that short-term particulate concentrations occasionally exceed the 24-hr standard as a result of naturally occurring dust storms.

The regional and Hanford Site geology is dominated by a sequence of Miocene continental flood basalts, designated the Columbia River Basalt Group. This layered sequence consists of basalt flows up to 4,270 m (14,001 ft) thick, interbedded with Miocene to Pliocene sediments such as silts, sands, and gravels. The surface is veneered with loess and sand dunes of varying thickness. The depth to groundwater in the 200 Areas is about 75 m (246 ft).

Earthquakes in the central portion of the Columbia Plateau are deep, generally single, isolated quakes occurring in the crust layers beneath the basalts, or shallow earthquake swarms occurring within the Columbia River Basalt Group. The largest magnitude earthquake recorded to date within the Columbia Basin was the 1936 Milton-Freewater earthquake, centered in northeastern Oregon. It had a magnitude of 5.75 on the Richter Scale. This earthquake is assumed to have had a peak horizontal ground acceleration of 0.10 gravity.

There are no perennial or ephemeral streams in the 200 West Area. The 200 West Area lies within the watershed of Cold Creek, an ephemeral stream, but the 200 West Area is not within the 100-year floodplain. There are no regulated wetlands within the 200 West Area. The Hanford Reach of the Columbia River has been proposed for designation as a Wild and Scenic River by the National Park Service.

The Hanford Site is a relatively large, undisturbed area of shrub-steppe habitat containing numerous plant and animal species adapted to the region's semiarid environment. No plants or animals on the federal or state lists of endangered and threatened wildlife and plants are found in the immediate vicinity of the 200 West Area.

Although the Hanford Site contains numerous well-preserved archaeological sites representing both the prehistoric and historical periods, there are no identified archaeological sites or artifacts in the vicinity of the 233-S Facility. The closest identified site is the White Bluffs Road, which crosses diagonally (southwest to northeast) through the northern portion of the 200 West Area. The road, formerly an Indian trail, has been in use since antiquity, and has played a role in early immigration, development, and agriculture.

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3.0 HAZARD ANALYSIS

3.1 HAZARD DESCRIPTION

Although potential health impacts to the D&D technicians are anticipated to be of greatest concern, potential impacts from both routine operations and postulated accident scenarios have been assessed with respect to the potential consequences to other onsite workers, and the general public.

The evaluation basis accident scenario postulated is that during removal of a section of a process vessel, the section is dropped. This sets off a chain of events that may result in a fire being started by one of the portable electric lamps. The presence of combustible material, in conjunction with the airflow through the work area, may cause the fire to rapidly grow to the point that the room fills with smoke and the building must be evacuated. The Hanford Fire Department is assumed to be able to extinguish the fire within approximately one hour of its outset. It is reasonable to expect that the initial burst of airborne plutonium, arising from the energy of the drop itself, is successfully contained by the temporary confinement structures within the room, and by the 233-SA Building exhaust. Therefore, it is postulated that the source term resulting from the accident is produced solely by the fire, and that the building exhaust filters are in that case ineffective, because they would quickly be clogged by the heavy smoke. The material at risk is assumed to be the inventory contained within the vessel section that was dropped (the inventory remaining in the assembly section still in the array is to an extent also at risk, but since the section is still closed at its top, and is held by the array in its original vertical position the contribution to the source term would be minor). In the worst case, this would be one half of the L-16 inventory, or 265 grams. DOE (1994) suggests release parameters for heated, contaminated noncombustible material of 6.0 x 10^{-3} airborne release fraction (ARF), with a respirable fraction (RF) of 0.01. The 233-S Facility source term is estimated as:

[inventory at risk] x [ARF] x [RF]

or

$$(265 \text{ grams}) (6.0 \times 10^{-3}) (0.01) = 0.016 \text{ grams}$$

Using the standard specific activity for material, which is predominately Pu-239, 6.13 x 10^{-2} Ci/g (U.S. Department of Health, Education, and Welfare [HEW] [HEW 1970]); 0.016 grams is equivalent to 9.7 x 10^{-4} Ci. This source term will result in an estimated dose consequence to hypothetical individuals located at an arbitrary distance near the facility (the maximum onsite individual), and at the site boundary (the maximum offsite individual). Doses are estimated according to the formula:

Dose = [source term] x [dispersion factor] x [breathing rate] x [unit dose]

Dispersion factors of 3.4×10^{-2} sec/m^3 for onsite exposures at approximately 100 m (328 ft) from the release site (Westinghouse Hanford Company [WHC] [WHC 1996]) and 1.9×10^{-5} sec/m^3 for offsite (WHC 1994) were selected as typical. The unit dose conversion factor for Pu-239 is 3.1×10^8 rem/Ci, and the standard breathing rate is 3.3×10^{-4} m^3/sec (EPA 1988). The estimated dose to a hypothetical onsite individual is:

$(9.7 \times 10^{-4})\ (3.4 \times 10^{-2})\ (3.3 \times 10^{-4})\ (3.1 \times 10^{8}) = 3.4$ rem, uncorrected for building wake effects.

Similarly, the maximum offsite dose is determined to be 1.9×10^{-3} rem, which is negligible. Since the 233-S Facility adjoins the massive canyon structure of the 202-S REDOX Plant, building wake correction is appropriate. Applying a building wake correction of 0.33 (WHC 1996) yields a corrected onsite dose estimate of 1.1 rem. Depending on the physical state the 233-S Facility was left in after the evacuation, building removal effects, consisting primarily of deposition of smoke borne contamination on the building interior surfaces, can be significant. If all exterior doors remain shut throughout the course of the accident, as required by the project's emergency plan, a building removal factor of 10 is reasonable. DOE (1994) assigns an additional removal factor of 10 to account for the effect of loose rubble on resuspension of loose contamination from exposed surfaces, and Walker (1978) cites a building reduction factor of 5.5 as typical for particles larger than 10 microns. Thus, the anticipated onsite maximum dose consequences from the 233-S Facility evaluation basis accident range from 0.11 - 1.1 rem.

The potential exists for non-accident release of radioactive emissions during the decommissioning activities in the 233-S Facility. Routine activities could result in two sources of chronic radiological hazards: (1) internal exposure to airborne radioactivity by inhalation and/or ingestion and (2) external exposure due to proximity to radioactive materials in the structures. Airborne radioactivity is a potential hazard for decommissioning workers, other site workers, and the public. External radiation exposure is a potential hazard only to directly involved workers.

Because of as low as reasonably achievable concerns, specific data on expected radiation exposure to workers during hazardous phases of decommissioning activities will be developed as part of the work planning when actual measurements of radiation/contamination levels will be obtained. A conservative upper-bound estimate of exposure may be made by assuming that the workers receive a dose that corresponds to the administrative control level set by the Hanford Site construction contractor (0.5 rem). This administrative control level can be exceeded to a cumulative maximum of 2.0 rem/yr only under certain situations and with the appropriate management approval. Such controls ensure that, under normal operating conditions, workers will not be exposed to levels approaching the DOE limit of 5 rem/yr.

Several techniques will be utilized during the D&D activities to assure that radioactive emissions from the facility remain within permitted levels.

- The 233-SA Building exhaust system will remain functional and operating continuously during all phases of the project up to the point that the dispersible inventory of residual radionuclides have been adequately removed or otherwise stabilized.
- Surface coatings and other means of fixing surface contamination will be used to the maximum extent practical.
- Positive confinement procedures, such as crimping and bagging operations, will be used during system dismantlements to prevent contamination release.
- Stack sampling instrumentation will be maintained during the project activities to ensure the filters do not accumulate large loadings and to ensure that the pre-filter continuous air monitor and post-filter samples are in operation.
- Local confinement "greenhouses" will be constructed around work areas that have the potential to generate large amounts of airborne activity.

The hazards associated with the D&D activities of the 233-S and 233-SA facilities were determined to be predominately radioactive. According to a chemical characterization survey performed (WHC 1993), there are no significant inventories of hazardous chemicals remaining in the facilities. Bulk quantities of materials were also removed. Thus, from the standpoint of nonradioactive hazards, the facilities do not appear to pose any significant risk to onsite individuals, the general public, or the environment.

According to BHI[a] (1996), the plutonium contained in the process vessels can be assumed to be in the form of an oxide or nitrate film spread fairly uniformly over the inside surfaces of the vessels and piping. The DOE Handbook (DOE 1994) provides release parameters for most accident situations, and was consulted for fractions appropriate to the 233-S Facility. While no release parameters specific to plutonium films inside thick-walled pipes were found, analogous (and suitably conservative) scenarios were provided. These included the release fractions observed when enclosed HEPA filters were dropped (ARF of 5×10^{-4}), and when containers of contaminated solid waste were subjected to impacts strong enough to rupture the container (ARF of 1×10^{-3}, RF of 0.1). Thus, a release fraction in the range of from 1×10^{-4} to 5×10^{-4} is postulated as reasonable for a scenario in which one of the vessel segments is dropped after being removed from the array, and prior to being sealed into a waste drum.

3.2 HAZARD SUMMARY

Relevant to the emergency preparedness requirements of the DOE Order 5500.2B (DOE 1991) and its implementing document (DOE-RL 1995), this plutonium comprises the vast majority of the hazardous material inventory of concern to site emergency planning. The 233-S Facility is contaminated with fixed radioactive material in several areas; additionally, there is a potential for small amounts of hazardous material within the facility. However as noted in WHC (1993) most of the nonradioactive hazardous materials have been removed from the facility. The fixed radioactive surface contamination likewise represents a hazard to the facility workers, but is of only minor concern to site emergency planning.

DOE (1991) specifies that an "alert" class emergency be declared whenever the nature of the situation is such that the release is not expected to exceed the site-specific Protective Action Guides (PAG). DOE-RL (1995) specifies a radiological PAG of 0.11 to 1.1 rem. The postulated evaluation basis accident consequences are negligible offsite and 0.11 rem onsite. This indicates that in the event of a fire at the 233-S Facility during the short period of time (several months) that the contents of the process array are at risk and provided the building is properly secured, an operational emergency class of "alert" is the highest level that would be expected.

4.0 SAFETY FUNCTION AND CONTROLS

Activities related to the project will have controls to provide adequate safety and health protection for the D&D workers against potential impacts of routine and unanticipated operational upsets. The D&D workers performing the project activities will be at the highest risk, therefore administrative controls pertinent to worker safety will be the predominate features in providing protection from project hazards.

A PHA (Appendix A) was performed for the D&D operations of 233-S and 233-SA facilities and identified preventive measures relative to the D&D activities. As a result, it was determined that existing state and federal codes, standards, regulations, and contractor procedures will provide sufficient controls during D&D activities.

The National Standards, State Codes and procedures that are applicable to the D&D project include:

- 10 CFR 835, Occupational Radiation Protection
- 29 CFR 1910, Occupational Safety and Health Standards
- 29 CFR 1910.1101, Asbestos, Appendices F and G
- 29 CFR 1926, Construction Standards
- 36 CFR 800, National Historic Preservation Act
- 40 CFR 61, Emission Standards for Air Pollutants
- 40 CFR 761, Toxic Substances Control Act
- 49 CFR 100-199, Transportation
- 50 CFR 402, Endangered Species Act
- 16 USC 703, Migratory Bird Treaty Act
- NFPA 70, National Fire Protection Code
- WAC 173-303, Dangerous Waste Regulations
- WAC 173-304, Minimum Functional Standards for Solid Waste Handling
- WAC 173-400, General Regulations for Air Pollution Sources

- WAC 246-247, Radiation Protection - Air Emissions
- WAC 296-24, General Safety and Health Standards
- WAC 296-44, Safety Standards for Electrical Construction Code
- WAC 296-45, Safety Standards - Electrical Workers
- WAC 296-62, Occupational Health Standards - Safety Standards for Carcinogens
- WAC 296-155, Safety Standards for Construction Work

Procedures, reviewed by BHI Engineering, and Quality, Safety and Health departments, will be prepared to ensure careful handling and assay of selected process components to verify the inventory assumptions of the criticality evaluation.

The D&D project workers will utilize existing procedures such as safety management, training, and staffing as requirements in performing all activities related to the D&D project. The D&D project team will also maintain a site-specific HASP that is controlled and approved by BHI. The HASP will include task specific assessments and will be regularly updated to account for increased facility knowledge and steadily decreasing hazards. In parallel with the Radiation Work Permits, compliance to BHI requirements will also be maintained.

Summary of controls to be developed in the remedial design report include:

- Verify inventory characteristics to ensure validity of the evaluations and assumptions of the criticality evaluation
- Radiological work controls in RWPs and implementing work procedures
- Site-Specific Health and Safety Plan
- Maintenance of the 233-SA Exhaust System
- Verification that these commitments are incorporated into the work procedures and that personnel are prepared prior to the start of the decommissioning work.

5.0 REFERENCES

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APPENDIX A

PRELIMINARY HAZARDS ANALYSIS FOR D&D OPERATIONS IN FACILITIES 233-S AND 233-SA

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1.0 INTRODUCTION

The 233-S Plutonium Concentration Facility was built in 1955 and has been in a continual state of deterioration since its deactivation in 1967. As a result of this facility having only minimal surveillance and maintenance performed, adequate safety analysis documentation was not kept up-to-date, other than routine surveillance and maintenance records and some documentation on previous D&D projects. The advanced state of facility deterioration has now required prompt attention and inventory removal.

The PHA was based on the following:

- Material provided with the RFP include:
  - Draft D&D Plans
  - Neutron Survey Report
  - Miscellaneous Supporting Documentation
- Personnel Interviews
- Facility Survey.

The PHA was developed using the following:

- Guidelines For Hazard Evaluation Procedures, AICHE
- DOE/EH-0486, Lessons Learned From PUREX

The PHA focuses in a general way on the hazardous materials and major areas of the facility and is intended to be a precursor to further hazard analyses, (i.e., Task-Based Hazard Analyses, HASP).

2.0 RESULTS AND CONCLUSIONS

The following table represents the results of the PHA performed. The table contains the hazards considered, potential relevant accidents and potential corrective actions and preventive measures. Most of the hazards identified are of concern to the workforce, but not to individuals outside the facility boundary. It is expected that the HASP that is being developed to support 233-S D&D activities will include consideration of these hazards.

The National Standards, State Codes and procedures that are applicable to the D&D project include:

- 10 CFR 835, Occupational Radiation Protection
- 29 CFR 1910, Occupational Safety and Health Standards
- 29 CFR 1910.1101, Asbestos, Appendices F and G
- 29 CFR 1926, Construction Standards
- 36 CFR 800, National Historic Preservation Act
- 40 CFR 61, Emission Standards for Air Pollutants
- 40 CFR 761, Toxic Substances Control Act
- 49 CFR 100-199, Transportation
- 50 CFR 402, Endangered Species Act
- DOE Order 5480.28, Natural Phenomena Hazards Mitigation (Protective requirements that are based on hazard classification)
- 16 USC 703, Migratory Bird Treaty Act
- NFPA 70, National Fire Protection Code
- WAC 173-303, Dangerous Waste Regulations
- WAC 173-304, Minimum Functional Standards for Solid Waste Handling
- WAC 173-400, General Regulations for Air Pollution Sources
- WAC 246-247, Radiation Protection - Air Emissions

- WAC 296-24, General Safety and Health Standards
- WAC 296-44, Safety Standards for Electrical Construction Code
- WAC 296-45, Safety Standards - Electrical Workers
- WAC 296-62, Occupational Health Standards - Safety Standards for Carcinogens
- WAC 296-155, Safety Standards for Construction Work

As the D&D planning for the 233-S D&D project matures, it is recommended that:

- Task specific hazards assessments should be conducted and documented in the HASP
- The HASP should be regularly updated to account for increased facility knowledge and steadily decreasing hazard.

Hazard	Accident Condition	Major Effects	Corrective/Preventive Measures
Fire	1) Electrical spark from portable lights, heaters, etc.	Potential release of radioactive material to 233-S	a) Minimize combustible loadings/house cleaning b) De-energize all portable equipment when 233-S is unoccupied
	2) Portable heaters, lights, etc. malfunctions	Potential release of radioactive material outside of 233-S	c) Installed fire alarm system operable d) Fire extinguishers available
	3) Metal cutting activities	Potential injury and excessive contamination to worker	e) Fire protection training f) Minimal energized electrical connections - the only installed energized circuits remaining are those necessary to power 233-SA and the fire alarm panel
	4) Electrical Dist. System Short Circuits	Toxic fumes, vapors in work area	g) Individuals working in contaminated areas are already wearing respiratory protective devices (e.g., PAPR, bubble suit) h) Use of non-abrasive, non-flame dismantlement methods to maximum extent practical i) Cellular/land line telephones
Excessive airborne contamination	1) Inadvertent startup of supply fan	Higher dose/ contamination risk to worker	a) Lockout/tagout supply fan b) Portable continuous air monitors in use near work area
	2) Breach of vacuum cleaner exhaust	Uncontrolled spread of radioactive material	c) Use of misters/foggers or stabilizing agents d) Manual cleaning alternatives

Hazard	Accident Condition	Major Effects	Corrective/Preventive Measures
Excessive airborne contamination (contd)	3) Dropped vessel 4) Multiple D&D activities 5) Airflow reversal 6) Loss of 233-SA Building exhaust air	Spread of contamination outside 233-S facility	e) Inspected/approved rigging points f) Personnel Protective Equipment (e.g., supplied air) g) Plan of the Day[1] h) Rigorous contamination control procedures, including"outside in" approach to D&D of facility i) Audible/visual warning for exhaust fan failure j) Housekeeping k) Local contamination control measures specific to material removal and movement l) Other measures as specified by Activity Hazard Analysis worksheets
Extreme ambient air temperatures	1) High/Low temperature due to weather conditions	D&D personnel discomfort, increased error probability D&D operational upsets/malfunctions (e.g., cracked visqueen, tape won't stick, etc.)	a) Personnel protective equipment (e.g., supplied heated or cooled air) b) Portable heaters for temperature control c) Plan of the Day[1] d) BHI-SH-02, Volume 3, *Safety and Health Procedure*, 4.1.2, "Temperature Extremes" e) Other measures as specified by Activity Hazard Analysis worksheets

Hazard	Accident Condition	Major Effects	Corrective/Preventive Measures
Flooding	1) Water leaks through roof	Potential for electrical shock Potential for contamination spread	a) Roof over process area has been repaired b) Minimal energized electrical connections - the only installed energized circuits remaining are power to 233-SA and the alarm panel c) Temporarily contain/reroute water in-leakage d) Plan of the Day[1]
Suspended loads (by cranes, workers)	1) Overhead load dropped	Potential for injury to worker Potential spread of radioactive material	a) Plan of the Day[1] b) Personnel protective equipment (e.g., hard hats, safety shoes) c) Continuous air monitors d) Exhaust system operable e) All lift points inspected and approved f) BHI-FS-0l, Field Support Administration, Procedure 9.1, "Rigging" g) Hoisting and Rigging Training h) Inspection of hoists/rigging equipment i) Other protective measures as specified by Activity Hazard Analysis worksheets

Hazard	Accident Condition	Major Effects	Corrective/Preventive Measures
Radiolytic gas in vapor space of vessels	1) Explosion caused by static sparks, vessel cutting, etc. 2) Rapid de-pressurization through opening in low point drain path	Potential for injury to worker Potential spread of radioactive material	a) Vessels purged via low point drains and vessel vents b) Drain paths will be opened with greenhouse confinement still in place c) Continuous air monitors alert personnel to problem (high airborne activity) d) Personnel protective equipment (e.g., supplied air) e) Use only non-abrasive, non-flame cutting methods when initially opening process piping systems f) Plan of the Day[1] g) Other protective measures as specified by Activity Hazard Analysis worksheets
Fissile material	1) Geometrically favorable array compromised	Potential for worker death caused by unshielded criticality. Exposure of onsite personnel to fission product gases.	a) Criticality analysis indicates criticality not credible, even if vessels are filled with water. b) Vessels are verified to be empty prior to removal, as part of D&D process c) Results of assay of vessel segments will be used to back check and verify criticality analysis

Hazard	Accident Condition	Major Effects	Corrective/Preventive Measures
Nonradiological hazards	1) D&D operational upsets/ malfunctions	Potential for increased worker exposure to hazardous chemicals	a) Chemicals not present in bulk quantities (to be confirmed during D&D activities) b) Work controlled by specific hazardous waste handling procedures (e.g., asbestos removal) c) Personnel protection equipment (e.g., bubble suits) d) Plan of the Day[1] e) Other measures as specified by HASP f) Other measures as specified by Activity Hazard Analysis worksheets

[1] Plan of the Day - To include lessons learned, hold points, activity status, and any safety issues to resolve.

APPENDIX B

233-S PHA MEETING ROSTER

233-S Lunchroom 4/10/96 at 1:30pm

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06/21/1996

233-S PHA Meeting
233-S Lunchroom 1:30PM

4/10/96

individual	work area/specialty
John Hinckley	Safety analysis
TB Myers	RCT
SJ Huddleston	RCT
Keith J. Lawing	RCT
JP Wilson	RCT
Scott Thoren	D&D Engineering
JL Davis	craft supt. BHI
CC Elledge	D&D Specialist
JS Pope	D&D & UW FAN
C A Krueger	D&D
TE Manley	D&D
BD Copenhaver	D&D
D A Foss	LATA

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